HYDROCARBON SERVICES

US EPA RECORDS CENTER REGION 5
504450

ENTERED

GROUND-WATER QUALITY ASSESSMENT
AND
GROUND-WATER SUPPLY EVALUATION

CINCINNATI ASPHALT REFINERY
FOR

CHEVRON USA, INC.

APRIL 1989

GERAGHTY & MILLER HYDROCARBON SERVICES, INC.
12101 E. 51st Street, Suite 104
Tulsa, Oklahoma 74146

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Cincinnati Asphalt Refinery reported ammonia contamination in its ground-water since 1979. The contamination has resulted in degradation of production water supply and necessitated undesirable and costly water treatment. Studies performed since that time suggested that the ground water in the northern part of the site may have been contaminated by ammonia from an adjacent agri-chemicals facility. These reports further suggested that wells could be located in the southeast part of the site near the Ohio river to provide the plant water supply.

A later report evaluated alternative water supply sources off-site and on-site, and evaluated alternative water treatment plans. That report recommended a Ranney collector well to be located near the river to furnish the plant water supply.

These studies recommended ground water supply development in the southeastern part of the site to take advantage of the river recharge effect and proposed withdrawal approaches that minimize drawdown to minimize potential for contaminant migration from the northern site area.

The present investigation was undertaken based on review and evaluation of the available data. That review was presented in a November 1988 report in which the present investigation was recommended to further evaluate present ground water quality, evaluate site aquifer co-efficients, and evaluate site hydraulic gradients. The overall objectives of the work were to: 1) assess ground-water quality, 2) confirm the potential for development of a suitable on-site water supply, and 3) make recommendations for water supply development. The specific items addressed included "confirmation" of hydraulic properties and water quality distribution in the southeastern part of the site where ground water withdrawal was proposed. The investigation included installation of new monitoring wells, sampling and analyses of new and existing wells and hydraulic testing of selected site wells.

The investigation also includes a plan to implement production test well installation and testing if site water quality and hydraulic conditions warranted. The production well plans were, however, canceled based on evaluation of field data as discussed below.

The evaluations performed confirmed that the present production wells located in the northern part of the site are contaminated by relatively high concentrations of ammonia and nitrate/nitrite. In the southeastern part of the site the aquifer water quality is better, however, nitrate/nitrite contamination is present at lower concentrations in one of the wells. The apparent southerly extent of the contaminant plume is, thus, greater than was anticipated based on the previous data. Withdrawal of ground water from the southeastern area as was previously proposed might result in further long term degradation of the water quality in that area.

The potential for "safe" long term withdrawal from the site aquifer is dependent on water quality in that area, aquifer transmissivity, and the direction and slope of the hydraulic gradient. As mentioned above , low concentrations of nitrate/nitrite contamination are present in the area, thus, inhibiting its use for water supply. The aquifer transmissivity is also apparently much lower than indicated in earlier reports. Testing during the present investigation indicates a transmissivity (T) of approximately 40,000 gallons per day per foot (gpd/ft) verses previous analyses which indicated a T of approximately 170,000 gpd/ft. The lower T further reduces the potential "safe yield" of the aquifer.

The proposed withdrawals from the aquifer in the southeastern part of the site, based on the water quality data, aquifer transmissivity, and hydraulic gradient, would probably result in further long term degradation of the ground water quality. Such withdrawals would, therefore, not produce reliable long term water supply and would not justify the costs of the proposed water supply systems.

Other water supply alternatives which have been evaluated in previous studies include off-site supplies and withdrawal from the river. These alternatives may merit further consideration.

Additional action which should be considered is the remediation of the site ground water contamination. Further investigations of the site contamination would appear to require off-site investigations in the area to the northeast of the site at an adjacent agricultural chemicals manufacturing facility. That area is immediately up gradient of the site and would be expected to store and handle materials and products which could be a potential source for the type of ground water contamination observed at the site. It is, therefore, a potential source which should be investigated.

The status of this potential source and any off-site investigative, mitigative or remedial actions which may be in progress or under consideration, if any, should also be evaluated. If none are planned or in progress, then such actions should be undertaken by appropriate parties.

INTRODUCTION

Investigation of ground-water quality in the subsurface at the Cincinnati Asphalt Refinery was prompted due to the reported contamination of the site ground-water supply with ammonia and nitrates. These studies recommended ground water supply development in the southeastern part of the site, located away from the area of contamination, and located to take advantage of the recharge effect of the adjacent Ohio River. The proposed withdrawal approaches were designed to minimize drawdown to minimize potential for contaminant migration from the northern site area. The proposed withdrawal rate was 300 to 400 gallons per minute (gpm) as is reportedly required for the plant water supply.

The present investigation was undertaken as recommended by Geraghty & Miller Hydrocarbon Services (GMHS) in the November 1988 Preliminary Report based on review and evaluation of available data which indicated a favorable potential for development of on site ground water supply in the southeast part of the site as had been recommended in previous studies.. The work was performed to assess ground-water quality, confirm the potential for development of a suitable on-site water supply, and make recommendations for water supply development. Specific areas of interest included the southerly extent of contamination between the potential source and the proposed withdrawal location, and the hydraulic conductivity and gradient in that area.

These objectives were accomplished by review and evaluation of pertinent information on the site area using available data and the existing site monitoring well network; and installation, sampling and analyses and testing of new monitoring wells. Subsurface exploration, soil sampling, water level elevations measurements, hydraulic testing and analyses, and water quality sampling and analysis were performed.

The investigation also included a planned production test well program to be carried out based on field evaluation of the drilling, sampling and testing described above. The production test well program was not carried out principally because the field evaluation indicated that the contaminant plume potentially extended into the proposed southeastern withdrawal area, and the site aquifer productivity was substantially lower than had been indicated in earlier reports as will be discussed in sections below.

SITE DESCRIPTION

General

The Cincinnati Asphalt Refinery is located in extreme southwestern Ohio in Hamilton county, just outside the western city limits of Cincinnati in the North Bend area (Figure 1). The refinery is in a low lying area located in the Ohio River valley on Brower Road with its southern most border on the north bank of the Ohio River.

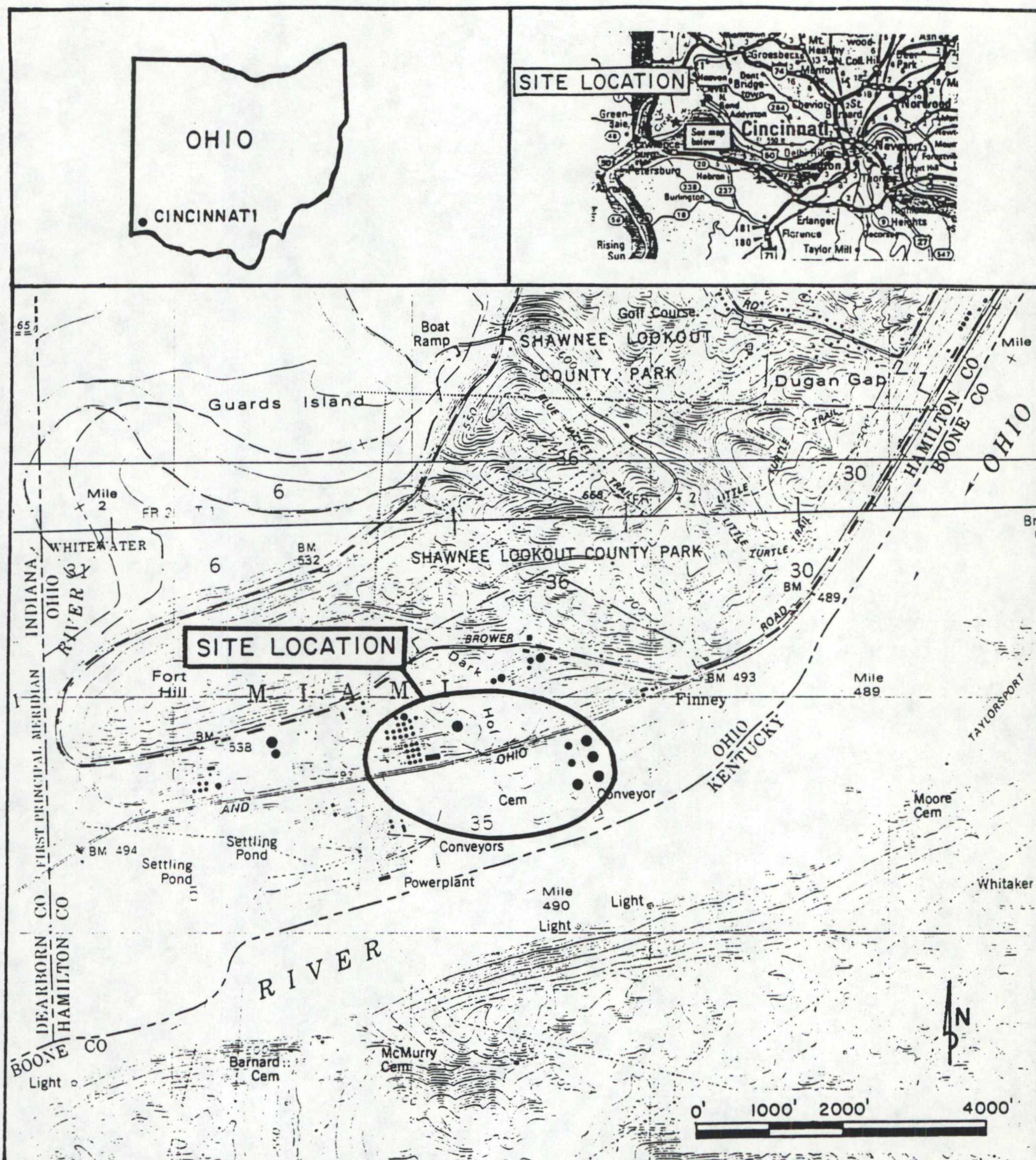
Primary land use in the area consists of industrial facilities. The asphalt refinery is immediately down-stream and to the west of the Kaiser Chemical Company (agri-chemical manufacturing) and just up-stream to the north and east of a Cincinnati Gas and Electric (CG&E) Power Plant.

The asphalt refinery plant, operating since 1954, handles both raw materials and finished asphalt products. The majority of product at this facility is stored in above-ground tanks except for gasoline for the service vehicles.

Topography and Drainage

The industrial sector is located in a low lying area on the north bank of the Ohio River. Relatively steep bluffs boarder this area to the north which cause surface water to flow toward it during periods of water runoff. The drainage of the refinery area itself continues generally to the south toward the Ohio River with a gradual slope of about 4 percent. For 10 miles above the area and several miles below, the profile of the Ohio River is almost flat (Fenneman, 1948).

Rainfall in the Cincinnati area is generally evenly distributed through-out the year with an annual average precipitation of 39.44 inches (US DOC, 1968). However, periodic heavy precipitation may cause large annual fluctuations in the ground water level elevations, particularly in the low lying areas.



CHEVRON,USA
CINCINNATI ASPHALT REFINERY

TOPOGRAPHIC SITE
LOCATION MAP

G&M SPILL AND TANK MANAGEMENT INC.

QUADRANGLE
LAWRENCEBURG, IND.
N3900-W8445/7.5
1981
DMA 4062 III SE-SERIES V851
CONTOUR INTERVAL 10 FT.

FIGURE 1

PREVIOUS REPORTS

The Cincinnati Asphalt Refinery reported ammonia contamination in its ground-water supply sometime prior to July 1979. Since that time several studies have been performed to determine ground water quality and possible alternative water supply sources for the site area.

The studies reviewed by GMHS include:

1) AQUIFER ANALYSIS OF A SIX-INCH DIAMETER WATER QUALITY TEST WELL CHEVRON U.S.A. INC. HAMILTON COUNTY, OHIO
   July 26, 1979, Reynolds Supply, Inc.

2) GROUND WATER CONTAMINATION STUDY OF A PLEISTOCENE GLACIAL OUTWASH DEPOSIT HAMILTON COUNTY OHIO
   August 10, 1979, Reynolds Supply, Inc.

3) REPORT OF GROUNDWATER INVESTIGATION -PHASE I CINCINNATI ASPHALT REFINERY
   November 21, 1984, Stokely-Cheeks And Associates, Inc.

4) REPORT ON STUDY TO PROVIDE ALTERNATE WATER SOURCE FOR CHEVRON ASPHALT REFINERY CINCINNATI, OHIO
   May 25, 1988, Camargo Associates, Inc.

5) HYDROGEOLOGIC REPORT CHEVRON ASPHALT TERMINAL NORTH BEND, (CINCINNATI) OHIO
   July 1988, National Petroleum Testing Consultants, Inc.

These studies included placement of monitoring wells, water level measurement, water quality analysis, aquifer testing and data interpretation.

The reports by Reynolds Supply suggested that the site ground water may have been contaminated by several possible sources including ammonia from the Kaiser agri-chemicals facility, chloride from Chevron brine pits and sulfate from CG&E coal storage. The chloride and sulfate contamination reported were relatively minor. Reynolds further suggested that a series of proposed wells located near the river could be used to provide the plant water supply.

The Stokley-Cheeks' study included several shallow borings and wells which reported no evidence of hydrocarbon contamination. No information was given with respect to the facility area prior to 1982, however, the study did indicate the facility has had no significant spills since April 1982.

Camargo's report evaluated alternative water supply sources off-site and on-site, and evaluated alternative water treatment plans. They recommended a Ranney collector well to be located near the river to supply the plant water supply of 300 to 400 gpm.

National Petroleum's report evaluated the vicinity hydrogeology to identify the potential water supply aquifer units. The sand and gravel unit adjacent to the river was indicated to be the best aquifer for industrial water supply development.

VICINITY HYDROGEOLOGY

In the site vicinity two major hydrogeologic units appear to be present, 1) alluvial (river valley) and 2) bedrock.

Alluvial Unit

The alluvial unit is present in major stream or river valleys. In the site area the alluvial unit can range from 0 to greater than 100 feet in thickness. The upper section of the alluvium (up to approximately 50 feet) may contain sand and considerable "fines" (clay and silt) that may retard recharge, confine, or semi-confine the aquifer. The lower section generally 50 feet or more thick consist of sands and gravels with the basal section including boulders and cobbles.

The permeable sand and gravel deposits in the stream valleys are one of the best ground-water producing aquifers in the Hamilton County area and are the only suitable aquifer for large industrial well field development in the site area. Well yields of 500 gpm or greater are common with yields of as much as 1,000 gallons per minute reported (Walker, 1986).

The water quality in the sand and gravel aquifer is generally good with pH from 7-8, total hardness approximately 150 to 450 milligrams per liter (mg/l), sulfate ($SO4$) from approximately 50 to 60 mg/l, iron (Fe) less than 5 mg/l, nitrate/nitrite approximately 0.1 mg/l, fluoride (F) between 0.1 and 0.2 mg/l, chloride (Cl) ranging from 20 to 30 mg/l, and calcium (Ca) between 50 to 120 mg/l.

Bedrock Unit

The bedrock unit consists of shales and thin limestone layers. The depth to bedrock generally ranges from 0 to 100 feet or more. The ground-water production in the unit is generally negligible in the site vicinity.

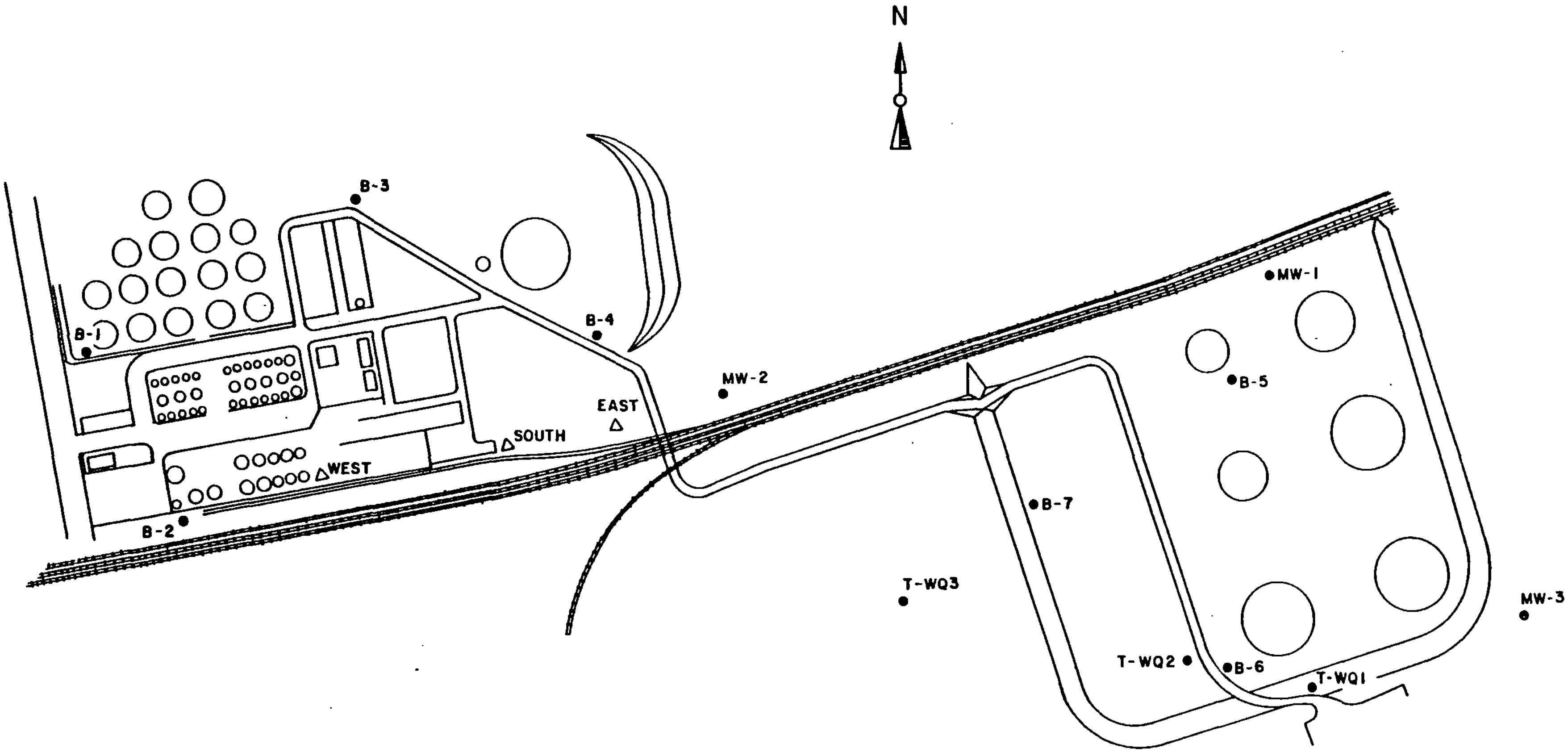
SITE HYDROGEOLOGY

The site hydrogeologic units encountered in the subsurface exploration during the present investigations (Figure 2) are consistent with the above descriptions of the aquifer units in the site vicinity. The alluvial unit consists of an upper finer grained section including sand, silt and clay from ground surface to depths ranging from approximately 30 to 50 feet, underlain by a predominantly coarse to medium sand with some gravel (Wentworth grain size classification) with thin interbeds of silty sand to depths as great as 120 feet.

On-site testing of the sand and gravel aquifer performed by Reynolds Supply indicated a transmissivity of approximately 170,000 gallons per day per foot (gpd/ft). However, based on testing performed by GMHS during the present investigation, the sand and gravel unit in the vicinity of the asphalt refinery has a transmissivity of approximately 40,000 gpd/ft. This transmissivity is consistent with the coarse to medium sand typical of the sand and gravel unit on site which would be expected to have a hydraulic conductivity on the order of 60 to 100 feet per day (ft/d) and saturated thicknesses of up to approximately 100 feet. The large difference in the reported transmissivities substantially affects the water production potential of the site aquifer.

Depth to ground water on site ranges from approximately 20 feet below ground surface in the southeastern part of the site near the river to 50 feet in the northwestern part of the site. Fluctuations of 5 feet have been recorded in a two month period between gaugings indicating considerable response of the water table elevation to recharge by the river and area rainfall. The hydraulic gradient has been determined using well elevation surveys completed in January, 1989. The water table gradient in the site area appears to be in the northwesterly direction with generally higher elevations near the river decreasing landward with a slope of approximately 0.0014 (Figure 3). River stage elevation also appears in general to be higher than the adjacent ground water levels, thus, apparently recharging the aquifer. Withdrawals at the site production wells ("west" and "south" Figure 3) would be expected to produce water table depressions in those areas.

G&M SPILL AND TANK MANAGEMENT INC.

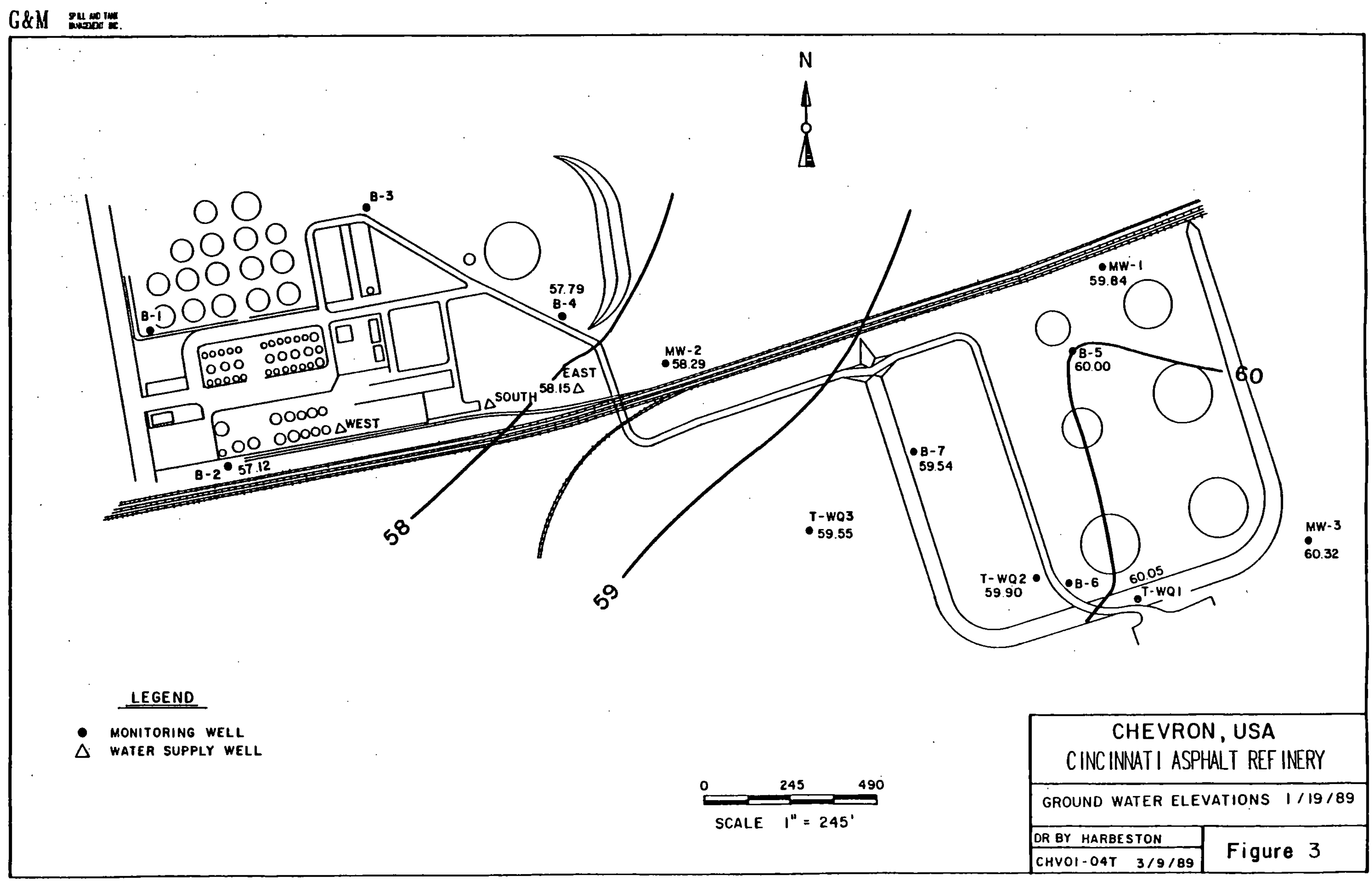


LEGEND

● MONITORING WELL
△ WATER SUPPLY WELL

0 245 490
SCALE 1" = 245'

CHEVRON, USA CINCINNATI ASPHALT REFINERY	
SITE MAP	
DR BY HARBESTON CHV01-04T 11/17/88	Figure 2


G&M
N
B-3
B-1
57.79
B-4
MW-2
58.29
EAST
58.15
SOUTH
WEST
B-2
57.12
58
59
60
MW-1
59.84
B-5
60.00
B-7
59.54
T-WQ3
59.55
T-WQ2
59.90
B-6
60.05
T-WQ1
MW-3
60.32
LEGEND
MONITORING WELL
WATER SUPPLY WELL
0
245
490
SCALE 1" = 245'
CHEVRON, USA
CINCINNATI ASPHALT REFINERY
GROUND WATER ELEVATIONS 1/19/89
DR BY HARBESTON
CHV01-04T 3/9/89
Figure 3

SITE GROUND WATER QUALITY

Site Monitoring Well Network

A monitoring well network of approximately 10 wells has been established in the refinery area during the period from 1979 to 1989. Reported locations of the monitoring wells are included in site location maps in the various reports received from Chevron USA. Apparently due to the number of different organizations involved with the monitoring well network several names may have been used for the same well. An on-site investigation of the monitoring well network was performed to confirmed the locations of those monitoring wells still in existence. These wells are presented on the site map (Figure 4) as B-1 through B-7, T-WQ1 thru T-WQ3 and MW-1 thru MW-3 locations. Table 1 shows the names GMHS will use and shows other pertinent information gathered during various field operations.

The seven "B-#" monitoring wells in the area were installed by Stokley-Cheeks and are constructed of 2 inch PVC casing and screen. Field measurements of six of these wells (B-6 could not be found) confirm the individual well logs (Appendix A) showing the wells completed in the upper sand, silt and clay unit at depths ranging from approximately 30 to 50 feet.. In the early part of October 1988, of the six B-# monitoring wells found, only B-4 and B-7 were capable of yielding enough water for water quality testing purposes. During a second round of sampling in January of 1989 the water level elevations had increased enough to retrieve an additional sample from monitoring well B-5 as well as B-4 and B-7. The remaining B-# monitoring wells were dry or would not yield the volume of water needed for sampling purposes. Visual inspection of the water samples after bailing wells B-4, B-5, and B-7 indicated that the samples were very muddy.

The B-# monitoring wells are in general too shallow and are of limited use for water quality sampling, however, their construction is satisfactory for some water level measurements, and they need not be abandoned.

G&M SPILL AND TANK MANAGEMENT INC.

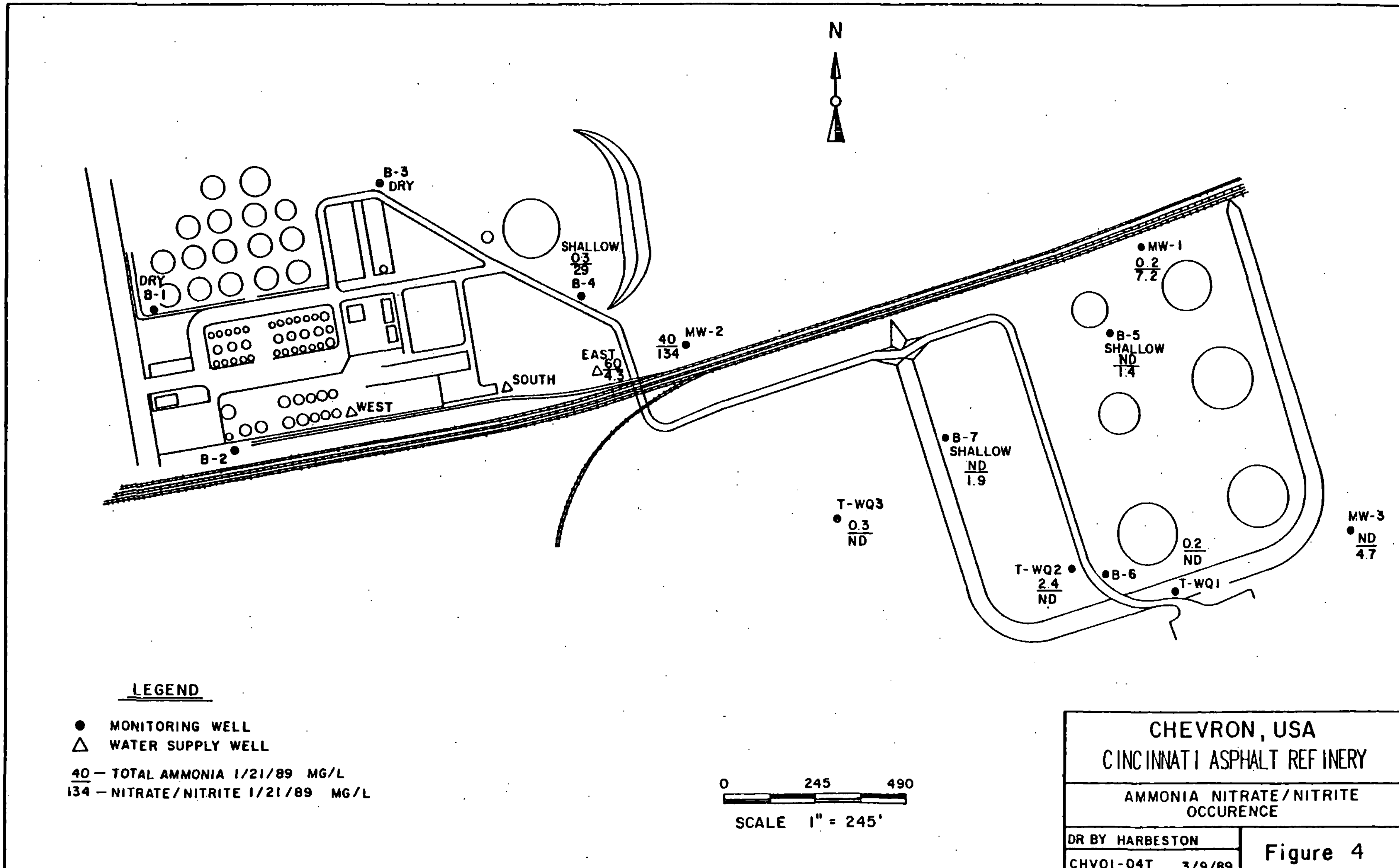


TABLE 1. - WELL SUMMARY

GMHS WELL NAME	OTHER POSSIBLE NAMES	TOP OF CASING ELEVATION (Ft MSL)	TOTAL DEPTH (Ft BTOC)	TOP OF SCREEN DEPTH (Ft BTOC)
B-1		515.05	31.90	6.00
B-2		497.37	45.11	20.00
B-3		514.77	52.27	11.10
B-4		504.39	53.10	19.10
B-5	MW-2	482.31	26.56	6.50
B-6	MW-4	WELL NOT FOUND		
B-7	MW-1	479.27	26.50	6.50
T-WQ1	MW-5	494.51	119.00	*
T-WQ2	MW-3	478.90	91.40	*
T-WQ3	MW-6	484.23	94.50	*
SOUTH		IN USE	*	*
WEST		IN USE	*	*
EAST		492.81	> 100.00	*
MW-1		483.03	93.00	23.00
MW-2		477.34	91.00	21.00
MW-3		479.40	105.50	15.50

Ft MSL - Feet above mean sea level
Ft BTOC - Feet below top of casing

* Data not available

Three other monitoring wells in the refinery area (T-WQ1 thru T-WQ3) were installed by Reynolds Supply and are constructed of 6 inch steel casing. The logs of these wells indicate that they are completed in the sand and gravel unit at depths from approximately 90 to 120 feet (Appendix A). The samples recovered from these wells were free of suspended material.

The "MW-" monitoring wells in the refinery area were installed by GMHS and are constructed of 4 inch PVC and 0.01-inch slot screen with flush thread joints. These well are completed in the sand and gravel unit at depths from approximately 90 to 110 feet (Appendix A). The water samples recovered from these wells were free of suspended material.

Other wells located in the site area include water supply production wells. The current water supply wells are indicated as "west" and "south" along with an apparently unused water supply source denoted as "east" on Figure 4. No logs or well construction data were obtained for these wells. Other apparently former production wells are reported on or near the site. No data was obtained regarding these additional wells.

Sampling

The results of the site ground water quality analyses performed in October of 1988 and January of 1989 are summarized in Table 2. Complete laboratory analyses are presented in Appendix B.

The criteria used to determine whether a well should be sampled was 1) location in the area of interest and, 2) the well needed to be able to produce enough fluid to purge the well for sampling and yield enough fluid to recover a reasonable sample.

Sampling procedures included equipment decontamination, measurement of ground-water elevations and purging of the wells. Samples for metals analysis were filtered, and all samples were preserved and promptly shipped together with appropriate records and documentation.

Field analyses were performed for temperature, conductivity, and pH and laboratory analyses were performed for the inorganic and organic parameters shown in Table 2. These parameters were

TABLE 2 - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE 10/6/88

	GMHS WELL IDENTIFICATION							
ANALYSIS - UNITS	WEST	SOUTH	B-4	B-7	T-WQ1	T-WQ2	T-WQ3	T-WQ3
Alkalinity, Total MG/L AS CACO3	334	474	446	212	68	58	40	46
Ammonia, Total MG/L AS N	32	250	0.2	0.1	0.6	3.5	0.7	0.6
Chloride MG/L	37	39	9	13	18	27	16	16
Fluoride MG/L	0.2	0.3	ND(0.1)	0.2	0.2	0.1	ND(0.1)	ND(0.1)
Nitrate/Nitrite MG/L AS N	20	220	11	2.9	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Orthophosphate MG/L AS P	ND(0.1)	ND(0.1)	ND(0.1)	0.8	0.2	0.2	ND(0.1)	ND(0.1)
pH STANDARD UNITS	7.2	7.7	6.8	7.1	8.5	8.3	8.1	8.3
Specific Conductance UMHOS/CM	1450	2660	1030	56	190	206	147	152
Sulfate MG/L	384	146	71	47	ND(10)	ND(10)	ND(10)	ND(10)
Total Organic Carbon MG/L	2	7	13	11	3	2	5	5
Calcium MG/L	209	160	197	93	9	10	7	8
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	51	42	39	17	8	6	6	6
Manganese MG/L	0.19	ND(0.02)	0.23	ND(0.02)	ND(0.02)	0.06	0.03	0.03
Potassium MG/L	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Silicon MG/L	7	6	6	6	ND(1)	ND(1)	ND(1)	ND(1)
Sodium MG/L	45	30	12	10	17	20	12	12
Conductance (field) UMHOS/CM	780	1400	520	680	200	280	160	NA
pH (field) STANDARD UNITS	7.2	7.7	6.7	6.9	7.6	7.2	7.7	NA
Temperature (field) C	15	15	15	13	15	15	15	NA

TABLE 2. - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE: 1/21/89

GMHS WELL IDENTIFICATION

ANALYSIS - UNITS	MW-1*	MW-1	MW-2	MW-3	T-WQ1	T-WQ2	T-WQ3	B-4
Alkalinity, Total MG/L AS CACO3	206	288	368	154	66	58	52	454
Ammonia, Total MG/L AS N	0.4	0.2	40	ND(0.1)	0.2	2.4	0.3	0.3
Chloride MG/L	23	91	35	6	18	26	21	38
Fluoride MG/L	0.2	0.2	0.2	0.2	0.2	0.1	ND(0.1)	ND(0.1)
Nitrate/Nitrite MG/L AS N	8	7.2	134	4.7	ND(0.1)	ND(0.1)	ND(0.1)	29
Orthophosphate MG/L AS P	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
pH STANDARD UNITS	7.3	7.0	6.9	6.2	8.3	8.1	8.2	6.7
Specific Conductance UMHOS/CM	711	1070	1890	490	240	190	150	1200
Sulfate MG/L	99	106	115	65	ND(10)	ND(10)	ND(10)	88
Total Organic Carbon MG/L	5	3	8	2	2	1	2	3
Calcium MG/L	100	164	235	70	11	10	8	220
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	27	44	57	22	9	6	6	44
Manganese MG/L	0.66	1.29	2.60	0.13	ND(0.02)	0.07	0.04	0.03
Potassium MG/L	21	7	6	ND(5)	ND(5)	ND(5)	ND(5)	5
Silicon MG/L	5	7.3	8.3	7.3	ND(1)	ND(1)	ND(1)	6.3
Sodium MG/L	11	22	34	9	18	21	12	22
pH (field) STANDARD UNITS	7.25	7.25	7.15	5.85	9.05	8.85	9.05	6.85
Temperature (field) C°	13	13	13.5	13	14	14.5	14	13.5

* Sampled on 1-12-89

TABLE 2.(continued) - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE 1/21/89

GMHS WELL IDENTIFICATION

ANALYSIS - UNITS	B-5	B-7	EAST
Alkalinity, Total MG/L AS CACO3	188	264	212
Ammonia, Total MG/L AS N	ND(0.1)	ND(0.1)	60
Chloride MG/L	ND(2)	11	43
Fluoride MG/L	0.2	0.2	0.1
Nitrate/Nitrite MG/L AS N	1.4	1.9	4.3
Orthophosphate MG/L AS P	ND(0.1)	0.1	ND(0.1)
pH STANDARD UNITS	7.2	7.0	8.3
Specific Conductance UMHOS/CM	410	660	890
Sulfate MG/L	11	55	99
Total Organic Carbon MG/L	2	5	4
Calcium MG/L	78	126	28
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	13	19	20
Manganese MG/L	ND(0.02)	ND(0.02)	0.03
Potassium MG/L	ND(5)	ND(5)	ND(5)
Silicon MG/L	3.8	6.3	2.6
Sodium MG/L	ND(5)	11	22
pH (field) STANDARD UNITS	7.55	7.15	8.9
Temperature (field) C°	13.5	14	14

chosen to characterize the general ground water quality and its suitability for industrial water supply.

Methods and procedures related to the sampling and analyses of ground water are presented in Appendix C.

Water Quality

As shown in Table 2, the water sampled in the northwestern part of the site (wells west, south, east, and MW-2; Figure 4) exhibit high nitrate/nitrite, ammonia, sulfate and somewhat higher chloride, sodium, specific conductance, and calcium and magnesium hardness. The nitrate/nitrite and ammonia are on the order of 10 to 1000 times greater than "background" and are present in concentrations greater than industrial or potable use criteria.

The results of analyses of water sampled from well B-4 exhibit higher than typical concentrations for a few parameters including nitrate/nitrite. However, the B-4 results may not be entirely representative because of its relatively shallow depth.

The analyses results for the wells in the southeastern part of the site (MW-1, MW-3, T-WQ1, T-WQ2, T-WQ3, B-5 and B-7; Figure 4) reflect generally good ground water quality and exhibit variable but generally low concentrations of nitrate/nitrite. The highest concentrations (7.2 milligrams per liter (mg/l)) occur at MW-1 which is the northern most well in this part of the site. The concentrations at MW-1 appear to indicate that nitrate/nitrite contamination may have migrated from the north or northeast to the MW-1 area. The MW-1 location is in the southeast part of the site and is potentially within the area of hydraulic influence of proposed ground water withdrawal locations in the southeast area. The apparent nitrate/nitrite contaminant plume, thus, extends into the proposed withdrawal area and would potentially migrate toward the withdrawal point or points in response to the gradient. Contaminant concentrations in the produced water would, therefore, tend to increase with time to concentrations similar to those observed at the northwestern wells.

FINDINGS

The present site ground water supply wells in the northwest part of the site are contaminated and the nitrate/nitrite contamination plume apparently extends at low concentrations at least as far into the southeast part of the site as the MW-1 location. Proposed ground water withdrawal points located in southeast part of the site would cause an increased southerly hydraulic gradient which would result in further southerly contaminant migration and ultimately, degradation of the southeastern area water quality. This result would also be somewhat accelerated by the cessation of pumping of the west and south production wells which serve to help maintain the present northwesterly gradient.

Based on the hydraulic properties of the site southeast aquifer, the proposed withdrawal of 300 to 400 gallons per minute from a single large diameter well or from three smaller wells spaced at 200 foot intervals along the river, would result in a hydraulic influence extending approximately to the MW-1 area. The resulting gradient would be expected to cause gradual degradation of the produced water over a period of several years. The proposed withdrawals would, therefore, not produce reliable long term water supply.

The previously proposed approaches to withdrawal of on-site ground water supplies included a proposal for a series of intermittently operated wells to be installed close to the river in the southeastern part of the site, and a proposal for a large diameter Ranney collector well to be installed in approximately the same area. Either system would also require associated water treatment systems. Installation of such relatively costly systems should not be undertaken without assurance of long term, satisfactory and reliable ground water quality.

Other water supply alternatives which have been evaluated in previous studies include off-site supplies and withdrawal from the river. These alternatives may merit further consideration.

Additional action which should be considered is the remediation of the site ground water contamination. Further investigations of the site contamination would appear to require off-site

Chevron USA Inc.
Cincinnati Asphalt Ref.
OHD 083 364 679

INTRODUCTION

Investigation of ground-water quality in the subsurface at the Cincinnati Asphalt Refinery was prompted due to the reported contamination of the site ground-water supply with ammonia and nitrates. These studies recommended ground water supply development in the southeastern part of the site, located away from the area of contamination, and located to take advantage of the recharge effect of the adjacent Ohio River. The proposed withdrawal approaches were designed to minimize drawdown to minimize potential for contaminant migration from the northern site area. The proposed withdrawal rate was 300 to 400 gallons per minute (gpm) as is reportedly required for the plant water supply.

The present investigation was undertaken as recommended by Geraghty & Miller Hydrocarbon Services (GMHS) in the November 1988 Preliminary Report based on review and evaluation of available data which indicated a favorable potential for development of on site ground water supply in the southeast part of the site as had been recommended in previous studies.. The work was performed to assess ground-water quality, confirm the potential for development of a suitable on-site water supply, and make recommendations for water supply development. Specific areas of interest included the southerly extent of contamination between the potential source and the proposed withdrawal location, and the hydraulic conductivity and gradient in that area.

These objectives were accomplished by review and evaluation of pertinent information on the site area using available data and the existing site monitoring well network; and installation, sampling and analyses and testing of new monitoring wells. Subsurface exploration, soil sampling, water level elevations measurements, hydraulic testing and analyses, and water quality sampling and analysis were performed.

The investigation also included a planned production test well program to be carried out based on field evaluation of the drilling, sampling and testing described above. The production test well program was not carried out principally because the field evaluation indicated that the contaminant plume potentially extended into the proposed southeastern withdrawal area, and the site aquifer productivity was substantially lower than had been indicated in earlier reports as will be discussed in sections below.

SITE DESCRIPTION

General

The Cincinnati Asphalt Refinery is located in extreme southwestern Ohio in Hamilton county, just outside the western city limits of Cincinnati in the North Bend area (Figure 1). The refinery is in a low lying area located in the Ohio River valley on Brower Road with its southern most border on the north bank of the Ohio River.

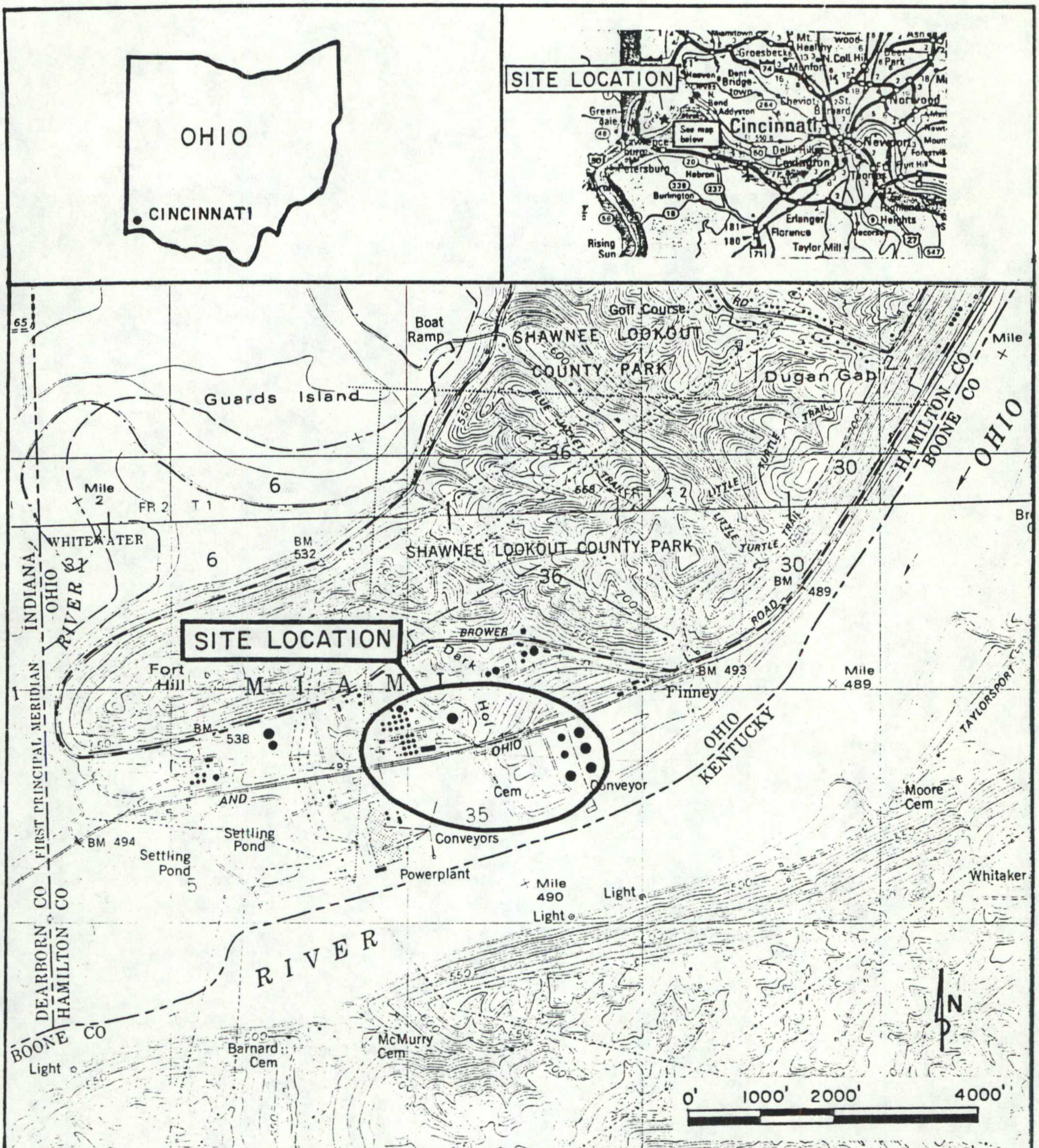
Primary land use in the area consists of industrial facilities. The asphalt refinery is immediately down-stream and to the west of the Kaiser Chemical Company (agri-chemical manufacturing) and just up-stream to the north and east of a Cincinnati Gas and Electric (CG&E) Power Plant.

The asphalt refinery plant, operating since 1954, handles both raw materials and finished asphalt products. The majority of product at this facility is stored in above-ground tanks except for gasoline for the service vehicles.

Topography and Drainage

The industrial sector is located in a low lying area on the north bank of the Ohio River. Relatively steep bluffs boarder this area to the north which cause surface water to flow toward it during periods of water runoff. The drainage of the refinery area itself continues generally to the south toward the Ohio River with a gradual slope of about 4 percent. For 10 miles above the area and several miles below, the profile of the Ohio River is almost flat (Fenneman, 1948).

Rainfall in the Cincinnati area is generally evenly distributed through-out the year with an annual average precipitation of 39.44 inches (US DOC, 1968). However, periodic heavy precipitation may cause large annual fluctuations in the ground water level elevations, particularly in the low lying areas.



CHEVRON USA
CINCINNATI ASPHALT REFINERY

TOPOGRAPHIC SITE
LOCATION MAP

G&M SPILL AND TANK MANAGEMENT INC.

QUADRANGLE
LAWRENCEBURG, IND.
N3900-W8445/7.5
1981
DMA 4062 III SE-SERIES V851
CONTOUR INTERVAL 10 FT.

FIGURE 1

VICINITY HYDROGEOLOGY

In the site vicinity two major hydrogeologic units appear to be present, 1) alluvial (river valley) and 2) bedrock.

Alluvial Unit

The alluvial unit is present in major stream or river valleys. In the site area the alluvial unit can range from 0 to greater than 100 feet in thickness. The upper section of the alluvium (up to approximately 50 feet) may contain sand and considerable "fines" (clay and silt) that may retard recharge, confine, or semi-confine the aquifer. The lower section generally 50 feet or more thick consist of sands and gravels with the basal section including boulders and cobbles.

The permeable sand and gravel deposits in the stream valleys are one of the best ground-water producing aquifers in the Hamilton County area and are the only suitable aquifer for large industrial well field development in the site area. Well yields of 500 gpm or greater are common with yields of as much as 1,000 gallons per minute reported (Walker, 1986).

The water quality in the sand and gravel aquifer is generally good with pH from 7-8, total hardness approximately 150 to 450 milligrams per liter (mg/l), sulfate (SO4) from approximately 50 to 60 mg/l, iron (Fe) less than 5 mg/l, nitrate/nitrite approximately 0.1 mg/l, fluoride (F) between 0.1 and 0.2 mg/l, chloride (Cl) ranging from 20 to 30 mg/l, and calcium (Ca) between 50 to 120 mg/l.

Bedrock Unit

The bedrock unit consists of shales and thin limestone layers. The depth to bedrock generally ranges from 0 to 100 feet or more. The ground-water production in the unit is generally negligible in the site vicinity.

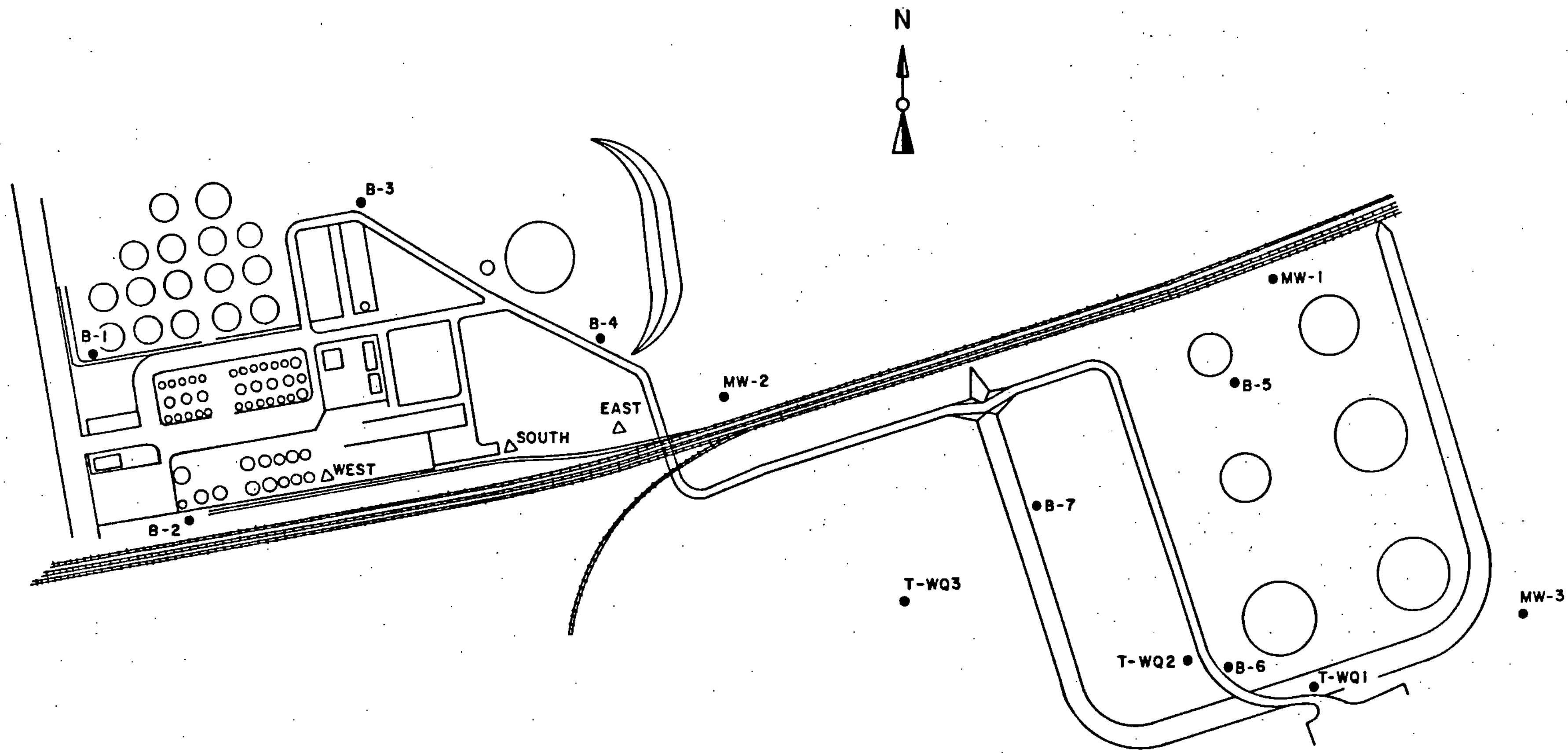
SITE HYDROGEOLOGY

The site hydrogeologic units encountered in the subsurface exploration during the present investigations (Figure 2) are consistent with the above descriptions of the aquifer units in the site vicinity. The alluvial unit consists of an upper finer grained section including sand, silt and clay from ground surface to depths ranging from approximately 30 to 50 feet, underlain by a predominantly coarse to medium sand with some gravel (Wentworth grain size classification) with thin interbeds of silty sand to depths as great as 120 feet.

On-site testing of the sand and gravel aquifer performed by Reynolds Supply indicated a transmissivity of approximately 170,000 gallons per day per foot (gpd/ft). However, based on testing performed by GMHS during the present investigation, the sand and gravel unit in the vicinity of the asphalt refinery has a transmissivity of approximately 40,000 gpd/ft. This transmissivity is consistent with the coarse to medium sand typical of the sand and gravel unit on site which would be expected to have a hydraulic conductivity on the order of 60 to 100 feet per day (ft/d) and saturated thicknesses of up to approximately 100 feet. The large difference in the reported transmissivities substantially affects the water production potential of the site aquifer.

Depth to ground water on site ranges from approximately 20 feet below ground surface in the southeastern part of the site near the river to 50 feet in the northwestern part of the site. Fluctuations of 5 feet have been recorded in a two month period between gaugings indicating considerable response of the water table elevation to recharge by the river and area rainfall. The hydraulic gradient has been determined using well elevation surveys completed in January, 1989. The water table gradient in the site area appears to be in the northwesterly direction with generally higher elevations near the river decreasing landward with a slope of approximately 0.0014 (Figure 3). River stage elevation also appears in general to be higher than the adjacent ground water levels, thus, apparently recharging the aquifer. Withdrawals at the site production wells ("west" and "south" Figure 3) would be expected to produce water table depressions in those areas.

G&M SPILL AND TANK MANAGEMENT INC.



LEGEND

● MONITORING WELL
△ WATER SUPPLY WELL

0 245 490

SCALE 1" = 245'

CHEVRON, USA
CINCINNATI ASPHALT REFINERY

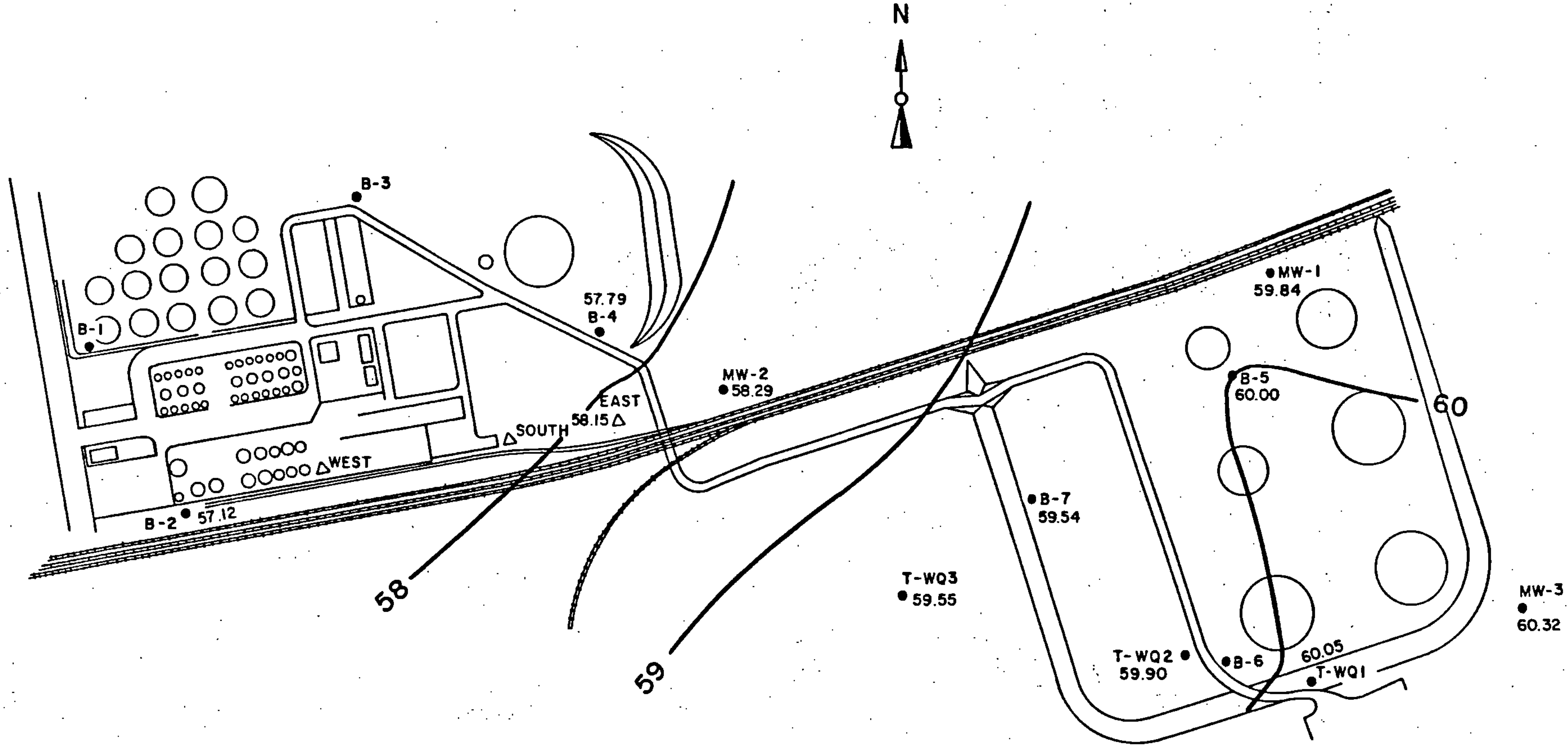
SITE MAP

DR BY HARBESTON

CHVO1-04T 11/17/88

Figure 2

G&M



LEGEND

● MONITORING WELL
△ WATER SUPPLY WELL

0 245 490

SCALE 1" = 245'

CHEVRON, USA
CINCINNATI ASPHALT REFINERY

GROUND WATER ELEVATIONS 1/19/89

DR BY HARBESTON
CHV01-04T 3/9/89

Figure 3

SITE GROUND WATER QUALITY

Site Monitoring Well Network

A monitoring well network of approximately 10 wells has been established in the refinery area during the period from 1979 to 1989. Reported locations of the monitoring wells are included in site location maps in the various reports received from Chevron USA. Apparently due to the number of different organizations involved with the monitoring well network several names may have been used for the same well. An on-site investigation of the monitoring well network was performed to confirmed the locations of those monitoring wells still in existence. These wells are presented on the site map (Figure 4) as B-1 through B-7, T-WQ1 thru T-WQ3 and MW-1 thru MW-3 locations. Table 1 shows the names GMHS will use and shows other pertinent information gathered during various field operations.

The seven "B-#" monitoring wells in the area were installed by Stokley-Cheeks and are constructed of 2 inch PVC casing and screen. Field measurements of six of these wells (B-6 could not be found) confirm the individual well logs (Appendix A) showing the wells completed in the upper sand, silt and clay unit at depths ranging from approximately 30 to 50 feet. In the early part of October 1988, of the six B-# monitoring wells found, only B-4 and B-7 were capable of yielding enough water for water quality testing purposes. During a second round of sampling in January of 1989 the water level elevations had increased enough to retrieve an additional sample from monitoring well B-5 as well as B-4 and B-7. The remaining B-# monitoring wells were dry or would not yield the volume of water needed for sampling purposes. Visual inspection of the water samples after bailing wells B-4, B-5, and B-7 indicated that the samples were very muddy.

The B-# monitoring wells are in general too shallow and are of limited use for water quality sampling, however, their construction is satisfactory for some water level measurements, and they need not be abandoned.

G&M SPILL AND TANK MANAGEMENT INC.

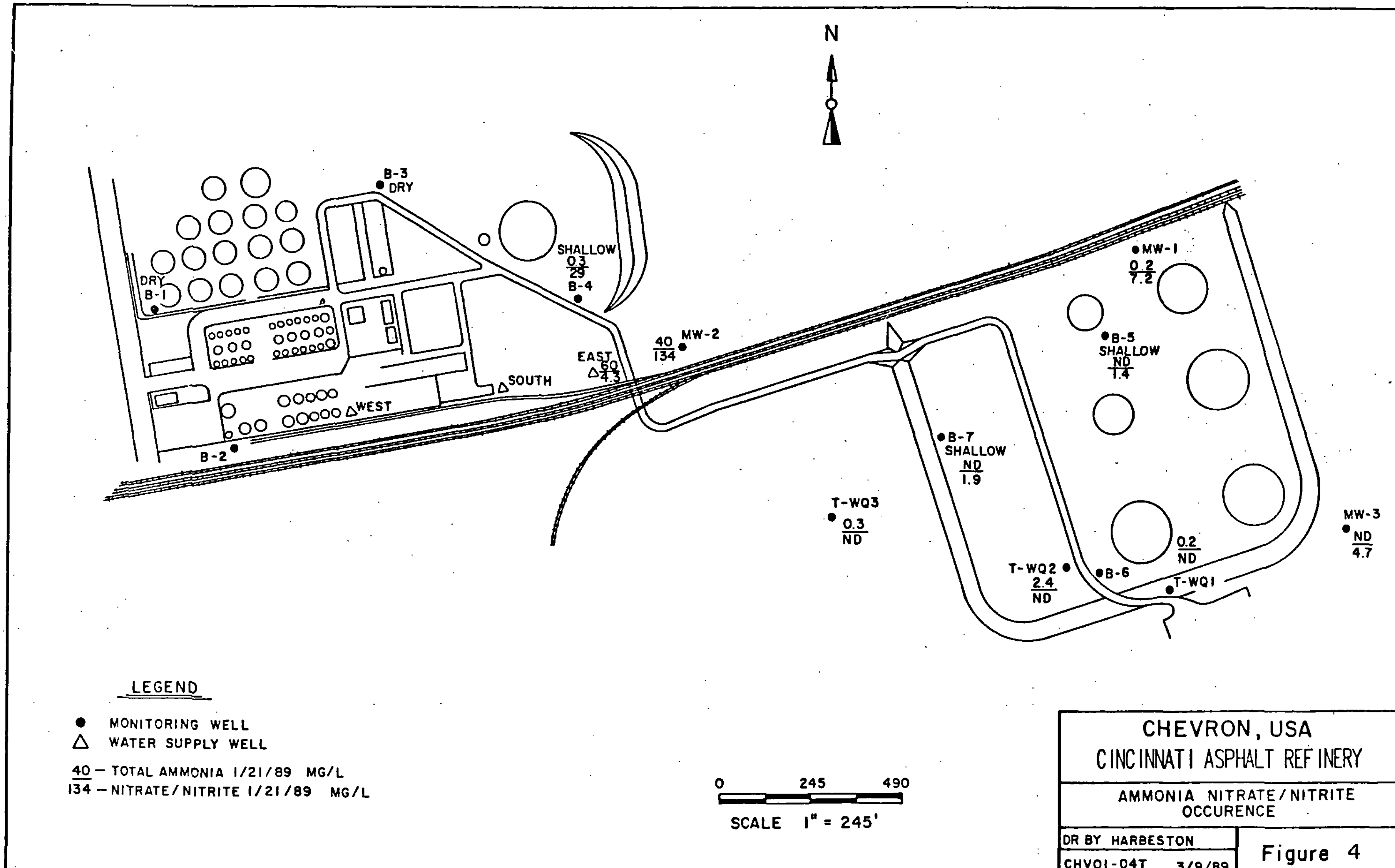


TABLE 1. - WELL SUMMARY

GMHS WELL NAME	OTHER POSSIBLE NAMES	TOP OF CASING ELEVATION (Ft MSL)	TOTAL DEPTH (Ft BTOC)	TOP OF SCREEN DEPTH (Ft BTOC)
B-1		515.05	31.90	6.00
B-2		497.37	45.11	20.00
B-3		514.77	52.27	11.10
B-4		504.39	53.10	19.10
B-5	MW-2	482.31	26.56	6.50
B-6	MW-4	WELL NOT FOUND		
B-7	MW-1	479.27	26.50	6.50
T-WQ1	MW-5	494.51	119.00	*
T-WQ2	MW-3	478.90	91.40	*
T-WQ3	MW-6	484.23	94.50	*
SOUTH		IN USE	*	*
WEST		IN USE	*	*
EAST		492.81	> 100.00	*
MW-1		483.03	93.00	23.00
MW-2		477.34	91.00	21.00
MW-3		479.40	105.50	15.50

Ft MSL - Feet above mean sea level
Ft BTOC - Feet below top of casing

* Data not available

Three other monitoring wells in the refinery area (T-WQ1 thru T-WQ3) were installed by Reynolds Supply and are constructed of 6 inch steel casing. The logs of these wells indicate that they are completed in the sand and gravel unit at depths from approximately 90 to 120 feet (Appendix A). The samples recovered from these wells were free of suspended material.

The "MW-" monitoring wells in the refinery area were installed by GMHS and are constructed of 4 inch PVC and 0.01-inch slot screen with flush thread joints. These well are completed in the sand and gravel unit at depths from approximately 90 to 110 feet (Appendix A). The water samples recovered from these wells were free of suspended material.

Other wells located in the site area include water supply production wells. The current water supply wells are indicated as "west" and "south" along with an apparently unused water supply source denoted as "east" on Figure 4. No logs or well construction data were obtained for these wells. Other apparently former production wells are reported on or near the site. No data was obtained regarding these additional wells.

Sampling

The results of the site ground water quality analyses performed in October of 1988 and January of 1989 are summarized in Table 2. Complete laboratory analyses are presented in Appendix B.

The criteria used to determine whether a well should be sampled was 1) location in the area of interest and, 2) the well needed to be able to produce enough fluid to purge the well for sampling and yield enough fluid to recover a reasonable sample.

Sampling procedures included equipment decontamination, measurement of ground-water elevations and purging of the wells. Samples for metals analysis were filtered, and all samples were preserved and promptly shipped together with appropriate records and documentation.

Field analyses were performed for temperature, conductivity, and pH and laboratory analyses were performed for the inorganic and organic parameters shown in Table 2. These parameters were

TABLE 2 - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE 10/6/88

	GMHS WELL IDENTIFICATION							
ANALYSIS - UNITS	WEST	SOUTH	B-4	B-7	T-WQ1	T-WQ2	T-WQ3	T-WQ3
Alkalinity, Total MG/L AS CACO3	334	474	446	212	68	58	40	46
Ammonia, Total MG/L AS N	32	250	0.2	0.1	0.6	3.5	0.7	0.6
Chloride MG/L	37	39	9	13	18	27	16	16
Fluoride MG/L	0.2	0.3	ND(0.1)	0.2	0.2	0.1	ND(0.1)	ND(0.1)
Nitrate/Nitrite MG/L AS N	20	220	11	2.9	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Orthophosphate MG/L AS P	ND(0.1)	ND(0.1)	ND(0.1)	0.8	0.2	0.2	ND(0.1)	ND(0.1)
pH STANDARD UNITS	7.2	7.7	6.8	7.1	8.5	8.3	8.1	8.3
Specific Conductance UMHOS/CM	1450	2660	1030	56	190	206	147	152
Sulfate MG/L	384	146	71	47	ND(10)	ND(10)	ND(10)	ND(10)
Total Organic Carbon MG/L	2	7	13	11	3	2	5	5
Calcium MG/L	209	160	197	93	9	10	7	8
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	51	42	39	17	8	6	6	6
Manganese MG/L	0.19	ND(0.02)	0.23	ND(0.02)	ND(0.02)	0.06	0.03	0.03
Potassium MG/L	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)
Silicon MG/L	7	6	6	6	ND(1)	ND(1)	ND(1)	ND(1)
Sodium MG/L	45	30	12	10	17	20	12	12
Conductance (field) UMHOS/CM	780	1400	520	680	200	280	160	NA
pH (field) STANDARD UNITS	7.2	7.7	6.7	6.9	7.6	7.2	7.7	NA
Temperature (field) C	15	15	15	13	15	15	15	NA

TABLE 2. - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE: 1/21/89

GMHS WELL IDENTIFICATION

ANALYSIS - UNITS	MW-1*	MW-1	MW-2	MW-3	T-WQ1	T-WQ2	T-WQ3	B-4
Alkalinity, Total MG/L AS CACO3	206	288	368	154	66	58	52	454
Ammonia, Total MG/L AS N	0.4	0.2	40	ND(0.1)	0.2	2.4	0.3	0.3
Chloride MG/L	23	91	35	6	18	26	21	38
Fluoride MG/L	0.2	0.2	0.2	0.2	0.2	0.1	ND(0.1)	ND(0.1)
Nitrate/Nitrite MG/L AS N	8	7.2	134	4.7	ND(0.1)	ND(0.1)	ND(0.1)	29
Orthophosphate MG/L AS P	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
pH STANDARD UNITS	7.3	7.0	6.9	6.2	8.3	8.1	8.2	6.7
Specific Conductance UMHOS/CM	711	1070	1890	490	240	190	150	1200
Sulfate MG/L	99	106	115	65	ND(10)	ND(10)	ND(10)	88
Total Organic Carbon MG/L	5	3	8	2	2	1	2	3
Calcium MG/L	100	164	235	70	11	10	8	220
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	27	44	57	22	9	6	6	44
Manganese MG/L	0.66	1.29	2.60	0.13	ND(0.02)	0.07	0.04	0.03
Potassium MG/L	21	7	6	ND(5)	ND(5)	ND(5)	ND(5)	5
Silicon MG/L	5	7.3	8.3	7.3	ND(1)	ND(1)	ND(1)	6.3
Sodium MG/L	11	22	34	9	18	21	12	22
pH (field) STANDARD UNITS	7.25	7.25	7.15	5.85	9.05	8.85	9.05	6.85
Temperature (field) C°	13	13	13.5	13	14	14.5	14	13.5

* Sampled on 1-12-89

TABLE 2.(continued) - SUMMARY OF GROUND-WATER QUALITY

SAMPLE DATE 1/21/89

GMHS WELL IDENTIFICATION

ANALYSIS - UNITS	B-5	B-7	EAST
Alkalinity, Total MG/L AS CACO3	188	264	212
Ammonia, Total MG/L AS N	ND(0.1)	ND(0.1)	60
Chloride MG/L	ND(2)	11	43
Fluoride MG/L	0.2	0.2	0.1
Nitrate/Nitrite MG/L AS N	1.4	1.9	4.3
Orthophosphate MG/L AS P	ND(0.1)	0.1	ND(0.1)
pH STANDARD UNITS	7.2	7.0	8.3
Specific Conductance UMHOS/CM	410	660	890
Sulfate MG/L	11	55	99
Total Organic Carbon MG/L	2	5	4
Calcium MG/L	78	126	28
Iron MG/L	ND(0.1)	ND(0.1)	ND(0.1)
Magnesium MG/L	13	19	20
Manganese MG/L	ND(0.02)	ND(0.02)	0.03
Potassium MG/L	ND(5)	ND(5)	ND(5)
Silicon MG/L	3.8	6.3	2.6
Sodium MG/L	ND(5)	11	22
pH (field) STANDARD UNITS	7.55	7.15	8.9
Temperature (field) C°	13.5	14	14

chosen to characterize the general ground water quality and its suitability for industrial water supply.

Methods and procedures related to the sampling and analyses of ground water are presented in Appendix C.

Water Quality

As shown in Table 2, the water sampled in the northwestern part of the site (wells west, south, east, and MW-2; Figure 4) exhibit high nitrate/nitrite, ammonia, sulfate and somewhat higher chloride, sodium, specific conductance, and calcium and magnesium hardness. The nitrate/nitrite and ammonia are on the order of 10 to 1000 times greater than "background" and are present in concentrations greater than industrial or potable use criteria.

The results of analyses of water sampled from well B-4 exhibit higher than typical concentrations for a few parameters including nitrate/nitrite. However, the B-4 results may not be entirely representative because of its relatively shallow depth.

The analyses results for the wells in the southeastern part of the site (MW-1, MW-3, T-WQ1, T-WQ2, T-WQ3, B-5 and B-7; Figure 4) reflect generally good ground water quality and exhibit variable but generally low concentrations of nitrate/nitrite. The highest concentrations (7.2 milligrams per liter (mg/l)) occur at MW-1 which is the northern most well in this part of the site. The concentrations at MW-1 appear to indicate that nitrate/nitrite contamination may have migrated from the north or northeast to the MW-1 area. The MW-1 location is in the southeast part of the site and is potentially within the area of hydraulic influence of proposed ground water withdrawal locations in the southeast area. The apparent nitrate/nitrite contaminant plume, thus, extends into the proposed withdrawal area and would potentially migrate toward the withdrawal point or points in response to the gradient. Contaminant concentrations in the produced water would, therefore, tend to increase with time to concentrations similar to those observed at the northwestern wells.

FINDINGS

The present site ground water supply wells in the northwest part of the site are contaminated and the nitrate/nitrite contamination plume apparently extends at low concentrations at least as far into the southeast part of the site as the MW-1 location. Proposed ground water withdrawal points located in southeast part of the site would cause an increased southerly hydraulic gradient which would result in further southerly contaminant migration and ultimately, degradation of the southeastern area water quality. This result would also be somewhat accelerated by the cessation of pumping of the west and south production wells which serve to help maintain the present northwesterly gradient.

Based on the hydraulic properties of the site southeast aquifer, the proposed withdrawal of 300 to 400 gallons per minute from a single large diameter well or from three smaller wells spaced at 200 foot intervals along the river, would result in a hydraulic influence extending approximately to the MW-1 area. The resulting gradient would be expected to cause gradual degradation of the produced water over a period of several years. The proposed withdrawals would, therefore, not produce reliable long term water supply.

The previously proposed approaches to withdrawal of on-site ground water supplies included a proposal for a series of intermittently operated wells to be installed close to the river in the southeastern part of the site, and a proposal for a large diameter Ranney collector well to be installed in approximately the same area. Either system would also require associated water treatment systems. Installation of such relatively costly systems should not be undertaken without assurance of long term, satisfactory and reliable ground water quality.

Other water supply alternatives which have been evaluated in previous studies include off-site supplies and withdrawal from the river. These alternatives may merit further consideration.

Additional action which should be considered is the remediation of the site ground water contamination. Further investigations of the site contamination would appear to require off-site investigations in the area to the northeast of the site at an adjacent agricultural chemicals manufacturing facility. That area is immediately up gradient of the site and would be expected to store and handle materials and products which could be a potential source for the type of ground water contamination observed at the site. It is, therefore, a potential source which should be investigated.

The status of this potential source and any mitigative or remedial actions which may be in progress or under consideration, if any, should also be evaluated.